(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 396 204 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification: **25.08.93 Bulletin 93/34**

(51) Int. Cl.$^5$: **F16L 13/02**, B23K 20/12

(21) Application number: **90201122.0**

(22) Date of filing: **03.05.90**

# (54) Method and device for joining well tubulars.

(30) Priority: **03.05.89 GB 8910118**

(43) Date of publication of application: **07.11.90 Bulletin 90/45**

(45) Publication of the grant of the patent: **25.08.93 Bulletin 93/34**

(84) Designated Contracting States: **DE FR GB IT NL**

(56) References cited:
**GB-A- 1 505 832**

(56) References cited:
**GB-A- 2 161 732**
**WELDING JOURNAL. vol. 66, no. 7, 1987, Miami, US, pages 40-47; Dunkerton et al: "Radial friction welding for offshore pipelines"**

(73) Proprietor: **SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.**
**Carel van Bylandtlaan 30**
**NL-2596 HR Den Haag (NL)**

(72) Inventor: **Heijnen, Wilhelmus Hubertus Paulus Marie**
**Schepersmaat 2**
**NL-9405 TA Assen (NL)**

EP 0 396 204 B1

## Description

The invention relates to a method and device for joining well tubulars.

During completion of an oil or gas production well elongate strings of well tubulars have to be inserted into the well to protect the well against caving in and to facilitate a safe production of oil and gas through the well. The conventional way of protecting a well against caving in is to create a casing by screwing together one or more strings of casing pipes that are lowered into the well and cemented in place. Production of oil and gas takes place via one or more elongate production strings, consisting of production tubes that are interconnected by screw thread couplings, which production strings are suspended within the interior of the casing.

Accordingly the conventional procedure for completing a well requires many hundreds of screw thread connections to be made. Making up of these connections at the drilling floor is a time consuming procedure and it requires use of carefully machined well tubulars.

British patent specification No. 1 505 832 discloses a method for joining tubulars, the method comprising the steps of:

- positioning a welding ring on one end of a first tubular element,
- placing a second tubular element against the welding ring,
- fixing the tubular elements in axial alignment with each other by means of clamps of a friction welding device, and
- rotating the welding ring by means of the friction welding device relative to the tubular elements while deforming the welding ring in radial sense such that the welding ring is in contact with the tubular elements thereby generating sufficient frictional heat to create a friction weld between the welding ring and the tubular elements.

This method is applicable to joining tubular elements which are in a horizontal position.

The present invention aims to provide a method and device for joining well tubulars in a vertical position by friction welding in an efficient and safe manner. The device should be easily movable such that it can be mounted on a drilling or workover rig. The method should be performed by drilling operators without broad expertise on welding technology, while use can be made of existing hoisting and rig equipment. Additionally associated explosion hazards in the event of escape of flammable fluids from the well should be minimized.

To this end the method for joining well tubulars according to the invention comprises the steps of

- lowering a first tubular element into a well until the upper end of the first tubular element is located in a substantially vertical orientation near the entrance of the well,
- positioning a welding ring on top of the first tubular element,
- hoisting a second tubular element to a substantially vertical position above the welding ring,
- fixing the tubular elements in axial alignment with each other by means of clamps of a friction welding device,
- rotating the welding ring by means of the friction welding device relative to the tubular elements while deforming the welding ring in radial sense such that the welding ring is in contact with the tubular elements thereby generating sufficient frictional heat to create a friction weld between the welding ring and the tubular elements, and
- lowering the interconnected tubular elements into the well,

wherein the welding ring is rotated around the tubular elements by rotating a tubular mid section of the friction welding device relative to a pair of tubular end sections of the device, the mid section carrying claw means for gripping the welding ring and each of the end sections carrying one of the clamps for fixing one of the tubular elements, and the mid section being connected to each of the end sections by a bearing unit, wherein the tubular mid section and the tubular end sections form a sealed chamber around the welding ring during the step of rotating the welding ring, wherein before and during the step of rotating the welding ring a mandrel is placed inside the tubular elements and clamped against their internal surfaces by means of a pair of clamps that are expanded against these surfaces at locations opposite to the locations where the clamps of the tubular end sections of the device are positioned, and wherein before the step of rotating the welding ring a sealing cup, which is mounted near the lower end of the mandrel, is expanded against the inner surface of the first tubular element so as to avoid ingress of flammable fluids via the interior of this tubular element to the location of the welding ring.

The invention furthermore relates to a device for joining well tubulars comprising:

- means for maintaining a first tubular element in a substantially vertical position suspended in a well while the upper end of the first tubular element is located near the entrance of the well,
- means for hoisting a second tubular element to a substantially vertical position above the suspended tubular element and a welding ring positioned on top of the first tubular element,
- clamps for fixing the tubular elements in axial alignment with each other, and
- a rotatable sleeve mounted between the clamps for rotating the welding ring relative to the tubular elements while deforming the weld-

ing ring in radial sense such that the welding ring is in contact with the tubular elements, thereby generating sufficient frictional heat to create a friction weld between the welding ring and the tubular elements,

wherein the rotatable sleeve is at each of its ends connected by a bearing unit to a tubular end section which carries at its inner surface one of the clamps which is securable around one of the tubular elements, wherein the rotatable sleeve contains an annular piston which has a tapered inner surface that surrounds the tapered outer surfaces of a series of claw means which are in use clamped around the welding ring by axially moving the piston relative to the sleeve, wherein sealing rings are arranged between the rotatable sleeve and the tubular end sections for providing in use with further seals a sealed chamber around the welding ring, wherein the hoisting means include a mandrel which is securable within the tubular elements by a pair of clamps that have the same axial spacing as the clamps of the tubular end sections between which the rotatable sleeve is arranged, and wherein the mandrel is at one of its ends connectable to a hoisting cable and is at its opposite end equipped with a sealing cup which in use seals off an annular space between the first tubular element and the mandrel in response to activation of the clamp which fixes the mandrel to the first tubular element.

The substantially vertical orientation of the tubular elements during the friction welding process according to the invention has the advantage that the upper end of the first tubular element, which is suspended in the well, can be firmly fixed near the drilling floor whereupon the second tubular element can be hoisted on top of the first element by means of the crown block of the drilling rig so that the welding process can be carried out with a relatively small mobile welding device which does not require a heavy foundation frame.

Reference is made to the article Radial Friction Welding for Offshore Pipelines by S.B. Dunkerton, A. Johansen and S. Frich, Welding Journal, Volume 66, No. 7, July, 1987, pages 40-47. This publication discloses radial friction welding wherein two pipe sections are welded together by rotating a welding ring arranged between the meeting ends of the pipe sections. This publication, however, is only related to welding offshore pipelines in a substantial horizontal position and not to welding tubulars on a drilling rig, no reference is made to vertical welding, facilitating handling of the pipe sections or to preventing flammable gases from contacting the hot weld section when the weld is made.

The invention will now be described in more detail with reference to the the accompanying drawings, in which:

- Figure 1 shows a section through a friction welding device according to the invention, a mandrel of the device being illustrated in phantom lines, and
- Figures 2A and 2B show sections through an upper and a lower section, respectively, of the mandrel of the device of Figure 1.

Figure 1 shows a friction welding device consisting of a mandrel 1 and an external portion 2 arranged around a first and a second tubular element 3 and 4, respectively, which elements are to be interconnected by the welding ring 5 to a string of well tubulars. At the right side of Figure 1 the external portion of the device is shown in an inactive position whereas at the left side of these Figures it is shown in an active position in which it is clamped to the tubular elements 3 and 4 and the welding ring 5.

The external portion 2 of the device consists of an upper tubular end section 7 and a lower tubular end section 8 and a tubular mid section 10 which is rotatably connected to the end sections 7 and 8 by two bearing units 11.

In the region of the bearing units 11 a number of sealing rings 12 are arranged between adjacent surfaces of the mid section 10 and the end sections 7 and 8, which together with a flexible sealing ring 13 and 13A of each end section 7 and 8 create a confined space 14 between the inner surface of the outer portion 2 of the friction welding device and the outer surfaces of the tubular elements 3 and 4 in the region of the welding ring 5.

The tubular mid section 10 consists of a pair of sleeves 15 that are screwed together, an annular piston 16 having a tapered inner surface and a series of claw segments 17 having tapered outer surfaces that are pressed against the tapered inner surface of the piston 16 by an expansion ring 18.

The annular piston 16 is at one of its ends slidably arranged inside an annular cylinder 19 which is in fluid communication with a fluid feed 20 via radial bores and an annular groove 21.

In use the claw segments 17 are clamped around the welding ring 5 by pumping hydraulic fluid via the fluid feed 20 into the cylinder 19 thereby urging the piston 16 to move in upward direction against the action of a spring 22 from the position shown at the right side of Fig. 1 to the position at the left side of Fig. 1. As a result of the upward movement of the piston 16 the claw segments 17 are pressed onto the welding ring 5 whilst rotation of the segments 17 relative to the rotating mid section 10 is prevented by radial grooves 24 in abutting radial end surfaces of the upper sleeve 15 and the segments 17.

The upper and lower tubular end sections 7 and 8 of the external portion 2 of the welding device are identical to each other. Therefore only the construction and operation of the upper tubular end section 7 will be described in detail.

The upper tubular end section 7 consists of two sleeves 30 and 31 which are screwed together, a cap

nut 32, a guide ring 33, a series of wedges 34, an actuator ring 35 and the flexible sealing ring 13.

In use the upper tubular end section 7 is clamped around the second tubular element 4 by screwing the cap nut 32 into the sleeve 30 from the position shown at the right side of Fig. 1 to the position shown at the left side of Fig. 1. The downward motion of the cap screw 32 is transferred via the guide ring 33 to the wedges 34 which slide along a tapered inner surface 38 of the sleeve 30 and are pressed onto the outer surface of the second tubular element 4. The lower tips 39 of the wedges 34 thereby press the actuator ring 35 in downward direction which causes the flexible sealing ring 13 to be pressed against the outer surface of the second tubular element 4 thereby providing a fluid tight seal between the second tubular element 4 and the upper tubular end section 7 of the welding device.

The lower tubular end section 8 consists of sleeves 30A and 31A which are screwed together, a cap nut 32A, a guide ring 33A, a series of wedges 34A, an actuator ring 35A and the flexible sealing ring 13A.

Operation of the lower tubular end section 8 is similar to operation of the upper tubular end section 7 described above.

It will be understood that if desired the cap nuts 32 and 32A for activating the wedges 34 and 34A may be replaced by hydraulic pistons or other actuator mechanisms.

Referring now to Figure 2A and 2B there is shown the construction of the mandrel 1 of the friction welding device. The mandrel 1 comprises a central body 50 which carries at its lower end a sealing cup 51 and around which an upper and a lower wedge assembly 52 and 53 and a split weld supporting sleeve 54 are arranged.

The split weld supporting sleeve 54 consists of two sleeve segments that are interconnected by dowels 55. Each sleeve segment may be equipped with electrical heater coils that are fed via electrical conduits passing through the central body 50.

The upper wedge assembly 52 consists of a series of wedges that are clamped between a tapered outer surface 57 of the central body 50 and inner surface of the second tubular element 4 by a downward motion of an upper actuator disc 58 relative to the central body 50. The upper actuator disc 58 is connected to a hollow actuator rod 59 by a locking nut 60.

The actuator rod 59 carries near its lower end a piston and stuffing box assembly 61 which is slidably secured inside a cylindrical chamber 62 formed in the central body 50. The chamber 62 is closed at its top by a cap 63 and by pumping fluid into the chamber 62 via a fluid feed conduit 64 and a bore 65 in the actuator rod 59, the actuator rod 59 is pushed into the upper end of the central body 50 against the action of a spring 66, thereby inducing the upper actuator disc 58 to clamp the upper wedge assembly 52 against the inner surface of the second tubular element 4.

The lower wedge assembly 53 is clamped against the inner surface of the first tubular element 3 by an upward motion of a lower actuator disc 70 relative to the central body 50.

The lower actuator disc 70 is connected to an elongated rod 71 by a locking nut 72. The rod 71 carries near its upper end a piston and stuffing box assembly 73 which is slidably arranged inside a cylindrical chamber 74 formed at the lower end of the central body 50. The chamber 74 is closed at its lower end by a cap 75 and by pumping fluid into the chamber 74 via fluid feed conduit 76 and a bore 77 passing through the central body 50 the rod 71 is pushed into the lower end of the body 50 against the action of a spring 78, thereby inducing the lower actuator disc 70 to clamp the assembly of wedges 51 against the inner wall of the first tubular element 3.

The rod 71 is at its lower end connected to a trapezoidal body 80 by a nut 81. The sealing cap 51 is held at a location just above the body by means of a support plate 82 which is locked by nuts 83 to a series of spacer rods 84. The spacer rods 84 pass through openings in the lower actuator disc 70 and are screwed into recesses 85 at the lower end of the central body 50.

The connection of the trapezoidal body 80 and the lower actuator disc 70 to the rod 71 facilitates a simultaneous activation of the sealing cup 51 and the lower wedge assembly 53. If the rod 71 is pulled into the lower end of the central body 50 by injecting fluid via the bore 77 into the chamber the wedge assembly 53 is clamped against the inner wall of the first tubular element 3 by the actuator disc 70 whereas at the same time the sealing cup 51 is clamped to the inner wall of the tubular element 3 by the movement of the trapezoidal body 80 towards the support plate 82.

Release of pressure inside the chamber 74, on the other hand, allows the spring 78 to push the rod 71 away from the central body 50 thereby inducing the simultaneous release of the wedge assembly 53 and sealing cup 51 from the inner wall of the first tubular element 3.

A preferred procedure for joining well tubulars with the device shown in Figures 1, 2A and 2b is as follows.

The external portion 2 of the friction device is mounted or suspended in a substantially vertical position above the wellhead (not shown) of the well in which the well tubulars are to be inserted, for example to create a casing string or one or more production strings.

The tubular elements for use in the string or strings are stored in a slant or vertical orientation in a pipe rack near the wellhead, and the external portion of the friction welding device is located above the well (not shown).

A first tubular element 3 is then retrieved from the pipe rack and lowered through the external portion 2 of the friction welding device into the well until the upper end of this element is located in a vertical orientation just above the upper clamp nut 32 of the external portion 2 of the friction welding device, whereupon the welding ring 5 is laid on top of the first tubular element 3.

Subsequently the internal mandrel 1 of the device, whilst it is suspended on a hoisting cable 6 carried by for example the crown block of a drilling rig mounted above the well, is lowered through the second tubular element 4 until the mandrel 1 protrudes about halfway from the lower end of this element 4.

Then the mandrel 1 is clamped to the inner wall of the second tubular element 4 by activating the upper wedge assembly 52 by injecting fluid into the chamber 62 via the conduit 64, whereupon the mandrel 1, with the second tubular element 4 attached thereto, is hoisted by the cable 6 to a vertical position above the first tubular element 3. As a next step the lower part of the mandrel 1 is stabbed through the welding ring 5 into the upper end of the first tubular element 3 until the lower end of the second tubular element 4 rests upon the welding ring 5 and/or the upper end of the first tubular element 3.

After establishing that the welding ring 5 and the abutting ends of the tubular elements 3 and 4 are properly located in co-axial orientations the lower wedge assembly 53 and the sealing cup 51 of the mandrel 1 are clamped to the inner wall of the first tubular element 3 by injecting fluid into the chamber 74 via the conduit 76.

Subsequently the external portion 2 of the device is axially moved relative to the mandrel 1 either by lowering the mandrel 1 with the tubular elements 3 and 4 clamped thereto, or by raising the external portion 2 of the device to a higher level above the wellhead, until the welding ring 5 is surrounded by the claw segments 17.

Then the wedges 34A and the flexible sealing ring 13A of the lower tubular end section 8 of the external portion 2 of the device are clamped around the first tubular element 3 by tightening of the cap nut 32A, whereas the wedges 34 and the flexible sealing ring 13 of the upper tubular end section 7 of the external portion of the device are clamped around the second tubular element 4 by tightening the cap nut 32. As the axial spacing between the wedges 34 and 34A is identical to the axial spacing between the wedge assemblies 52 and 53 of the mandrel 1 a high radial clamping force may be exerted between the wedges and the walls of the tubular elements 3 and 4 without the risk of deformation or rupture of these elements.

After having thus clamped the mandrel 1 and external portion 2 of the device to the tubular elements 3 and 4 in such a manner that any access of flammable gasses from the well to the region of the welding ring is prevented by the sealing cup 51 and sealing rings 12, 13 and 13A the claw segments 17 are clamped around the welding ring 5 by an upward movement of the annular piston 16 by means of pumping fluid via the fluid inlet 21 into the annular cylinder 19.

Subsequently the mid section 10 with the welding ring 5 attached thereto is rotated by means of a hydraulic or electric motor or a modified tubing torque tongs (not shown) relative to said end sections 7 and 8.

During the rotation of the mid section 10 the claw segments 17 exert a predetermined radial force to the welding ring 5. The magnitude of the radial force may be adjusted in relation to either the radial compression force exerted to the ring or to the radial deformation of the ring. The radial force exerted to the welding ring 5 and the speed of rotation of the conical inner surface of the welding ring 5 over the conical outer surfaces of the ends of the tubular elements 3 and 4 are of such a magnitude that sufficient frictional heat is generated to create a frictional weld between the welding ring 5 and tubular elements 3 and 4.

After creation of the weld a heat treatment of the weld and interconnected ends of the tubular elements 3 and 4 is carried out by heating the welding ring 5 and said ends of the tubular elements by means of the heating coils in the split weld supporting sleeve 54 of the mandrel 1. The heat treatment may also be conducted by an external heating device (not shown).

Subsequently the mandrel 1 and external portion 2 of the device are released from the welding ring 5 and the tubular elements 3 and 4 by releasing the claw segments 16 and the assemblies of wedges 34, 34A, 52 and 53 whereupon the created weld may be inspected.

A next tubular element may be connected on top of the second tubular element 4 by repeating the friction welding process described above, which process may be repeated again and again until the string of well tubulars has its required length.

In the above described method the first tubular element was lowered into the well through the external portion of the friction welding device. Alternatively, the first tubular element can be lowered into the borehole and the external portion of the friction welding device can be arranged on top of the first tubular element.

## Claims

1. A method for joining well tubulars (3, 4), the method comprising the steps of:
   - lowering a first tubular element (3) into a well until the upper end of the first tubular element (3) is located in a substantially vertical orientation near the entrance of the well,

- positioning a welding ring (5) on top of the first tubular element (3),
- hoisting a second tubular element (4) to a substantially vertical position above the welding ring (5),
- fixing the tubular elements (3, 4) in axial alignment with each other by means of clamps (34, 34A) of a friction welding device,
- rotating the welding ring (5) by means of the friction welding device relative to the tubular elements (3, 4) while deforming the welding ring (5) in radial sense such that the welding ring (5) is in contact with the tubular elements (3, 4) thereby generating sufficient frictional heat to create a friction weld between the welding ring (5) and the tubular elements (3, 4), and
- lowering the interconnected tubular elements (3, 4) into the well,

wherein the welding ring (5) is rotated around the tubular elements (3, 4) by rotating a tubular mid section (10) of the friction welding device relative to a pair of tubular end sections (7, 8) of the device, the mid section (10) carrying claw means (17) for gripping the welding ring (5) and each of the end sections (7, 8) carrying one of the clamps (34, 34A) for fixing one of the tubular elements (3, 4), and the mid section (10) being connected to each of the end sections (7, 8) by a bearing unit (11), wherein the tubular mid section (10) and the tubular end sections (7, 8) form a sealed chamber around the welding ring (5) during the step of rotating the welding ring (5), wherein before and during the step of rotating the welding ring (5) a mandrel (1) is placed inside the tubular elements (3, 4) and clamped against their internal surfaces by means of a pair of clamps (52, 53) that are expanded against these surfaces at locations opposite to the locations where the clamps (52, 53) of the tubular end sections (7, 8) of the device are positioned, and wherein before the step of rotating the welding ring (5) a sealing cup (51), which is mounted near the lower end of the mandrel (1), is expanded against the inner surface of the first tubular element (3) so as to avoid ingress of flammable fluids via the interior of this tubular element (3) to the location of the welding ring (5).

2. The method of claim 1, wherein the second tubular element (4) is hoisted to a position above the welding ring (5) by moving the mandrel (1) in downward direction therethrough, while the mandrel (1) is secured to a hoisting cable (6), until the mandrel (1) protrudes about halfway from the lower end of the second tubular element (4), whereupon one of the clamps (52) is expanded against its inner surface and the mandrel (1), while it carries the second tubular element (4), is lifted by the hoisting cable (6) to a vertical position above the first tubular element (3) whereupon the protruding end of the mandrel (1) is stabbed through the welding ring (5) into the first tubular element (3) and fixed thereto by expanding the other clamp (53) of the mandrel (1).

3. A device for joining well tubulars (3, 4) comprising:
   - means for maintaining a first tubular element (3) in a substantially vertical position suspended in a well while the upper end of the first tubular element (3) is located near the entrance of the well,
   - means for hoisting a second tubular element (4) to a substantially vertical position above the suspended tubular element (3) and a welding ring (5) positioned on top of the first tubular element (3),
   - clamps (34, 34A) for fixing the tubular elements (3, 4) in axial alignment with each other, and
   - a rotatable sleeve (10) mounted between the clamps (34, 34A) for rotating the welding ring (5) relative to the tubular elements (3, 4) while deforming the welding ring (5) in radial sense such that the welding ring (5) is in contact with the tubular elements (3, 4), thereby generating sufficient frictional heat to create a friction weld between the welding ring (5) and the tubular elements (3, 4),

wherein the rotatable sleeve (10) is at each of its ends connected by a bearing unit (11) to a tubular end section (7, 8) which carries at its inner surface one of the clamps (34, 34A) which is securable around one of the tubular elements (3, 4), wherein the rotatable sleeve (10) contains an annular piston (16) which has a tapered inner surface that surrounds the tapered outer surfaces of a series of claw means (17) which are in use clamped around the welding ring (5) by axially moving the piston (16) relative to the sleeve (10), wherein sealing rings (12) are arranged between the rotatable sleeve (10) and the tubular end sections (7, 8) for providing in use with further seals (13, 13A) a sealed chamber around the welding ring (5), wherein the hoisting means include a mandrel (1) which is securable within the tubular elements (3, 4) by a pair of clamps (52, 53) that have the same axial spacing as the clamps (34, 34A) of the tubular end sections (7, 8) between which the rotatable sleeve (10) is arranged, and wherein the mandrel (1) is at one of its ends connectable to a hoisting cable (6) and is at its opposite end equipped with a sealing cup (51) which in use seals off an annular space between the

first tubular element (3) and the mandrel (1) in response to activation of the clamp (53) which fixes the mandrel (1) to the first tubular element (3).

4. The device of claim 3, wherein the clamp (34, 34A) of each tubular end section (7, 8) consists of a series of wedges that are contained inside a tapered inner surface of the tubular end section (7, 8), each of the wedges facing at one end thereof an actuator ring (35, 35A) which is axially movable through the tubular end section (7, 8) by means of a nut (32, 32A) which is screwed into the terminal end of the end section (7, 8), and each of the wedges facing at another end thereof a ring (33, 33A) with tapered sides, which ring (33, 33A) activates in response to an inward movement of the wedges caused by tightening of the nut (32, 32A) to seal off the annular space between the tubular element (3, 4) and the surrounding tubular end section (7, 8).

5. The device of claim 3 or 4, wherein a mid portion of the mandrel (1) is surrounded by a split weld supporting sleeve (54) that has a slightly smaller external diameter than the internal diameter of the tubular elements (3, 4).

6. The device of claim 5, wherein the mandrel (1) is equipped with heating means for maintaining the split weld supporting sleeve (54) and the surrounding portions of the tubular elements (3, 4) at a desired temperature during and after the step of rotation of the welding ring (5).

**Patentansprüche**

1. Verfahren zum Verbinden von Futterrohren (3,4), wobei das Verfahren folgende Schritte aufweist:
   - Absenken eines ersten rohrförmigen Elementes (3) in einen Schacht, bis das obere Ende des ersten rohrförmigen Elementes (3) in einer im wesentlichen senkrechten Orientierung nahe dem Eingang des Schachtes angeordnet ist,
   - Positionieren eines Schmelzringes (5) am oberen Ende des ersten rohrförmigen Elementes (3),
   - Befördern eines zweiten rohrförmigen Elementes (4) zu einer im wesentlichen senkrechten Stellung oberhalb des Schmelzringes (5),
   - Fixieren der rohrförmigen Elemente (3,4) in axialer Ausrichtung miteinander durch Klammern (34, 34A) einer Reibungsschmelzeinrichtung,
   - Drehen des Schmelzringes (5) durch die Reibungsschmelzeinrichtung relativ zu den rohrförmigen Elementen (3,4) während des Verformens des Schmelzringes (5) in radialer Richtung, so daß der Schmelzring (5) in Kontakt mit den rohrförmigen Elementen (3,4) ist, wodurch eine genügende Reibungswärme erzeugt wird, um eine Reibungsschmelze zwischen dem Schmelzring (5) und den rohrförmigen Elementen (3,4) zu erzeugen, und
   - Absenken der verbundenen rohrförmigen Elemente (3,4) in den Schacht,

   wobei der Schmelzring (5) um die rohrförmigen Elemente (3,4) durch Drehen eines rohrförmigen Mittelbereiches (10) der Reibungsschmelzeinrichtung relativ'zu einem Paar von rohrförmigen Endbereichen (7,8) der Einrichtung gedreht wird, wobei der Mittelbereich (10) Klauen- bzw. Eingreifmittel (17) zum Greifen des Schmelzringes (5) hält und jeder der Endbereiche (7,8) eine der Klammern (34,34A) zum Fixieren eines der rohrförmigen Elemente (3,4) trägt, und der Mittelbereich (10) mit jedem der Endbereiche (7,8) durch eine Lagereinheit (11) verbunden ist, wobei der rohrförmige Mittelbereich (10) und die rohrförmigen Endbereiche (7,8) eine abgedichtete Kammer um den Schmelzring (5) während des Schrittes des Drehens des Schmelzringes (5) bilden, wobei vor und während des Schrittes des Drehens des Schmelzringes (5) ein Dorn (1) in den rohrförmigen Elementen (3,4) angeordnet ist und gegen ihre Innenflächen durch ein Paar von Klammern (52,53) geklemmt wird, die gegen diese Flächen an Stellen aufeinandergedrückt werden, die entgegengesetzt zu den Stellen sind, wo die Klammern (52,53) der rohrförmigen Endbereiche (7,8) der Einrichtung angeordnet sind, und wobei vor dem Schritt des Drehens des Schmelzringes (5) eine Dichtabdeckung (51), die nahe dem unteren Ende des Dornes (1) angebracht ist, gegen die Innenfläche des ersten rohrförmigen Elementes (3) auseinandergedrückt wird, um das Eindringen von entflammbaren Gasen bzw. Flüssigkeiten durch das Innere dieses rohrförmigen Elementes (3) an die Stelle des Schmelzringes (5) zu verhindern.

2. Verfahren nach Anspruch 1, wobei das zweite rohrförmige Element (4) an eine Position oberhalb des Schmelzringes (5) befördert wird durch Hindurchbewegen des Dornes (1) in Abwärtsrichtung, wobei der Dorn (1) an einem Förderkabel (6) befestigt ist, bis der Dorn (1) ungefähr auf halbem Weg von dem unteren Ende des zweiten rohrförmigen Elementes (4) vorsteht, woraufhin eine der Klammern (52) gegen die Innenfläche auseinandergedrückt wird und der Dorn (1), während er das zweite rohrförmige Element (4) trägt, durch das Förderkabel (6) in eine senkrechte

Stellung oberhalb des ersten rohrförmigen Elementes (3) gezogen wird, während das hervorstehende Ende des Dornes (1) durch den Schmelzring (5) in das erste rohrförmige Element (3) eingebracht wird und daran durch Aufeinanderdrücken der anderen Klammer (53) des Dornes (1) fixiert wird.

3. Eine Vorrichtung zum Verbinden von Futterrohren (3,4), die aufweist:
   - eine Einrichtung zum Festhalten eines ersten rohrförmigen Elementes (3) in einer im wesentlichen senkrechten Hängestellung in einem Schacht, während das obere Ende des ersten rohrförmigen Elementes (3) nahe dem Eingang des Schachtes angebracht ist,
   - eine Einrichtung zum Befördern eines zweiten rohrförmigen Elementes (4) an eine im wesentlichen senkrechte Stellung oberhalb des aufgehängten rohrförmigen Elementes (3) und eines Schmelzringes (5), der am oberen Ende des ersten rohrförmigen Elementes (3) angebracht ist,
   - Klammern (34, 34A) zum Fixieren der rohrförmigen Elemente (3,4) in axialer Ausrichtung miteinander, und
   - ein drehbares kurzes Rohr (10), das angebracht ist zwischen den Klammern (34,34A) zum Drehen des Schmelzringes (5) relativ zu den rohrförmigen Elementen (3,4), während des Verformens des Schmelzringes (5) in radialer Richtung, so daß der Schmelzring (5) in Kontakt mit den rohrförmigen Elementen (3,4) ist, wodurch eine ausreichende Reibungswärme erzeugt wird, um eine Reibungsschmelze zwischen dem Schmelzring (5) und den rohrförmigen Elementen (3,4) zu erzeugen,

   wobei das drehbare kurze Rohr (10) an jedem seiner Enden mit einer Lagereinheit (11) mit einem rohrförmigen Endbereich (7,8) verbunden ist, der an seiner Innenfläche eine der Klammern (34,34A) trägt, die sichernd um eines der rohrförmigen Elemente (3,4) angebracht ist, wobei das drehbare kurze Rohr (10) einen Ringkolben (16) enthält, der eine sich verjüngende bzw. kegelförmige Innenfläche aufweist, die die sich verjüngende bzw. kegelförmige Außenfläche einer Reihe von Klauen- bzw. Eingreifhilfsmitteln (17) umgibt, die während des Betriebes um den Schmelzring (5) durch axiale Bewegung des Kolbens (16) relativ zu dem kurzen Rohr (10) festgeklemmt sind, wobei die Dichtringe (12) zwischen dem drehbaren kurzen Rohr (10) und den rohrförmigen Endbereichen (7,8) angeordnet sind, um in Verwendung mit weiteren Dichtungen (13,13A) eine abgedichtete Kammer um den Schmelzring (5) zu schaffen, wobei die Födereinrichtung einen Dorn (1) aufweist, der sichernd in den rohrförmigen Elementen (3,4) durch ein Paar von Klammern (52,53) angeordnet ist, die den gleichen axialen Abstand wie die Klammern (34,34A) der rohrförmigen Endbereiche (7,8) aufweisen, zwischen denen das drehbare kurze Rohr (10) angebracht ist, und wobei der Dorn (1) an einem seiner Enden verbindbar mit einem Förderkabel (6) ist und an seinem entgegengesetzten Ende mit einer Dichtabdeckung (51) ausgestattet ist, die während des Betriebs einen ringförmigen Raum zwischen dem ersten rohrförmigen Element (3) und dem Dorn (1) ansprechend auf eine Aktivierung der Klammer (53) abdichtet, die den Dorn (1) an das erste rohrförmige Element (3) fixiert.

4. Die Einrichtung nach Anspruch 3, wobei die Klammer (34,34A) jedes rohrförmigen Endbereiches (7,8) eine Reihe von Keilen enthält, die in einer kegelförmigen bzw. sich verjüngenden Innenfläche des rohrförmigen Endbereiches (7,8) enthalten sind, wobei jeder der Keile an einem Ende davon einem Stellring (35,35A) gegenübersteht, der axial durch den rohrförmigen Endbereich (7,8) mittels einer mutterartigen Nuß (32,32A) bewegbar ist, die in den Endanschluß des Endbereiches (7,8) geschraubt ist, und jeder der Keile an einem anderen Ende davon einem Ring (33,33A) mit sich verjüngenden bzw. kegelförmigen Seiten gegenübersteht, wobei der Ring (33,33A) ansprechend auf eine Einwärtsbewegung der Keile aktiviert wird, die durch Festziehen der Nuß (32,32A) hervorgerufen wird, um den ringförmigen Raum zwischen den rohrförmigen Elementen (3,4) und dem umgebenden rohrförmigen Endbereich (7,8) abzudichten.

5. Einrichtung nach Anspruch 3 oder 4, wobei ein Mittelbereich des Dornes (1) durch ein spaltschmelzunterstützendes Rohr (54) umgeben ist, das einen Außendurchmesser aufweist, der ein wenig kleiner als der Innendurchmesser der rohrförmigen Elemente (3,4) ist.

6. Einrichtung nach Anspruch 5, wobei der Dorn (1) mit einer Heizeinrichtung zum Beibehalten einer gewünschten Temperatur an dem spaltschmelzunterstützenden kurzen Rohr (54) und den umgebenden Bereichen der rohrförmigen Elemente (3,4) während und nach dem Schritt des Drehens des Schmelzringes (5) ausgestattet ist.

**Revendications**

1. Procédé de connexion de tubulures de puits (3,

4), le procédé comportant les étapes consistant à :

- abaisser un premier élément tubulaire (3) dans un puits jusqu'à ce que l'extrémité supérieure du premier élément tubulaire (3) soit située selon une orientation à peu près verticale à proximité de l'entrée du puits,
- positionner un anneau de soudage (5) sur la partie supérieure du premier élément tubulaire (3),
- hisser un second élément tubulaire (4) dans une position à peu près verticale au-dessus de l'anneau de soudage (5),
- fixer les éléments tubulaires (3, 4) en alignement axial l'un par rapport à l'autre à l'aide de mâchoires (34, 34A) d'un dispositif de soudage par friction,
- faire tourner l'anneau de soudage (5) par rapport aux éléments tubulaires (3, 4) à l'aide du dispositif de soudage par friction tout en déformant l'anneau de soudage (5) dans une direction radiale de telle sorte que l'anneau de soudage (5) vienne en contact avec les éléments tubulaires (3, 4) engendrant ainsi une température de friction suffisante pour créer un soudage par friction entre l'anneau de soudage (5) et les éléments tubulaires (3, 4),
- abaisser les éléments tubulaires connectés (3, 4) dans le puits,

dans lequel l'anneau de soudage (5) est mis en rotation autour des éléments tubulaires (3, 4) en faisant tourner un tronçon médian (10) tubulaire du dispositif de soudage par friction par rapport à deux tronçons formant extrémités tubulaires (7, 8) du dispositif, le tronçon médian (10) portant des moyens (17) formant pinces pour saisir l'anneau de soudage (5) et chacun des tronçons d'extrémité (7, 8) portant une des mâchoires (34, 34A) pour fixer un des éléments tubulaires (3, 4), et le tronçon médian (10) étant relié à chacun des tronçons formant extrémités (7, 8) par un ensemble (11) formant palier, dans lequel le tronçon médian tubulaire (10) et les tronçons tubulaires formant extrémités (7, 8) forment une chambre étanche autour de l'anneau de soudage (5) pendant l'étape de mise en rotation de l'anneau de soudage (5), dans lequel avant et pendant l'étape de mise en rotation de l'anneau de soudage (5) un mandrin (1) est placé à l'intérieur des éléments tubulaires (3, 4) et serré contre leurs surfaces intérieures à l'aide d'une paire d'attaches (52, 53) qui sont écartées contre ces surfaces en des emplacements opposés aux emplacements auxquels les mâchoires (34, 34A) des tronçons formant extrémités tubulaires (7, 8) du dispositif sont positionnées, et dans lequel avant l'étape de mise en rotation de l'anneau de soudage (5) une coupelle d'étanchéité (51), qui est montée à proximité de l'extrémité inférieure du mandrin (1), est écartée contre la surface intérieure du premier élément tubulaire (3) de manière à éviter la progression de fluides inflammables à l'intérieur de cet élément tubulaire (3) jusqu'à l'emplacement de l'anneau de soudage (5).

2. Procédé selon la revendication 1, dans lequel le second élément tubulaire (4) est élevé jusqu'à une position située au-dessus de l'anneau de soudage (5) en déplaçant le mandrin (1) dans une direction vers le bas à travers celui-ci alors que le mandrin (1) est fixé à un câble de levage (6), jusqu'à ce qu'environ une moitié du mandrin (1) fasse saillie à partir de l'extrémité inférieure du second élément tubulaire (4), après quoi une des attaches (52) soit étendue contre sa surface intérieure et le mandrin (1), alors qu'il porte le second élément tubulaire (4), est levé par le câble de levage (6) jusqu'à une position verticale située audessus du premier élément tubulaire (3) après quoi l'extrémité en saillie du mandrin (1) est guidée à travers l'anneau de soudage (5) jusque dans le premier élément tubulaire (3) et fixée à celui-ci par extension de l'autre attache (53) du mandrin (1).

3. Dispositif de connexion de tubulures de puits (3, 4) comportant :

- des moyens pour maintenir un premier élément tubulaire (3) dans une position à peu près verticale et suspendu dans un puits alors que l'extrémité supérieure du premier élément tubulaire (3) est située à proximité de l'entrée du puits,
- des moyens de levage d'un second élément tubulaire (4) jusqu'à un position à peu près verticale au-dessus de l'élément tubulaire (3) suspendu et d'un anneau de soudage (5) positionné sur la partie supérieure du premier élément tubulaire (3),
- des mâchoires (34, 34A) destinées à fixer les éléments tubulaires (3, 4) en alignement axial l'un par rapport à l'autre, et
- un manchon (10) rotatif monté entre les mâchoires (34, 34A) pour faire tourner l'anneau de soudage (5) par rapport aux éléments tubulaires (3, 4) tout en déformant l'anneau de soudage (5) dans la direction radiale de telle sorte que l'anneau de soudage (5) vienne en contact avec les éléments tubulaires (3, 4), engendrant ainsi une température de friction suffisante pour créer une soudure par friction entre l'anneau de soudage (5) et les éléments tubulaires (3, 4),

dans lequel le manchon (10) rotatif est re-

lié à chacune de ces extrémités par un ensemble (11) formant palier à un tronçon formant extrémité tubulaire (7, 8) qui porte à sa surface intérieure une des mâchoires (34, 34A), qui peut être fixé autour d'un des éléments tubulaires (3, 4), dans lequel le manchon rotatif (10) contient un piston annulaire (16) qui a une surface intérieure conique qui entoure les surfaces extérieures coniques d'une série de moyens (17) formant pinces qui en utilisation sont serrées autour de l'anneau de soudage (5) par déplacement axialement du piston (16) par rapport au manchon (10), dans lequel des anneaux d'étanchéité (12) sont agencés entre le manchon rotatif (10) et les tronçons formant extrémités tubulaires (7, 8) pour fournir en utilisation avec d'autres joints (13, 13A) une chambre étanche située autour de l'anneau de soudage (5), dans lequel les moyens de levage comportent un mandrin (1) qui peut être fixé dans les éléments tubulaires (3, 4) à l'aide d'une paire d'attaches (52, 53) qui ont le même écartement axial que les mâchoires (34, 34A) des tronçons formant extrémités tubulaires (7, 8) entre lesquelles le manchon rotatif (10) est agencé, et dans lequel le mandrin (1), à l'une de ses extrémités, peut être relié à un câble de levage (6) et, à son extrémité opposée, est équipé d'une coupelle d'étanchéité (51) qui en utilisation rend étanche un espace annulaire situé entre le premier élément tubulaire (3) et le mandrin (1) en réponse à l'actionnement de l'attache (53) qui fixe le mandrin (1) sur le premier élément tubulaire (3).

4. Dispositif selon la revendication 3 dans lequel la mâchoire (34, 34A) de chaque tronçon formant extrémité tubulaire (7, 8) est constitué d'une série de coins qui sont reçus à l'intérieur d'une surface intérieure conique du tronçon formant extrémité tubulaire (7, 8), chacun des coins à l'une de ses extrémités, étant en vis à vis d'un anneau actionneur (35, 35A) qui est mobile axialement à travers le tronçon formant extrémité tubulaire (7, 8) par l'intermédiaire d'un écrou (32, 32A) qui est vissé dans l'extrémité terminale du tronçon formant extrémité (7, 8), et chacun des coins, à son autre extrémité, étant en vis à vis d'un anneau (33, 33A) ayant des faces coniques, lequel anneau (33, 33A) est actif en réponse à un mouvement vers l'intérieur des coins entraîné par vissage de l'écrou (32, 32A) pour isoler l'espace annulaire situé entre l'élément tubulaire (3, 4) et le tronçon formant extrémité tubulaire (7, 8) l'entourant.

5. Dispositif selon la revendication 3 ou 4, dans lequel un partie médiane du mandrin (1) est entourée par un manchon fendu (54) support de soudure qui a un diamètre extérieur légèrement plus petit que le diamètre intérieur des éléments tubulaires (3, 4).

6. Dispositif selon la revendication 5 dans lequel le mandrin (1) est équipé de moyens de chauffage destinés à maintenir le manchon fendu (54) de support de soudure et les parties environnantes des éléments tubulaires (3, 4) à une température voulue pendant et après l'étape de mise en rotation de l'anneau de soudage (5).

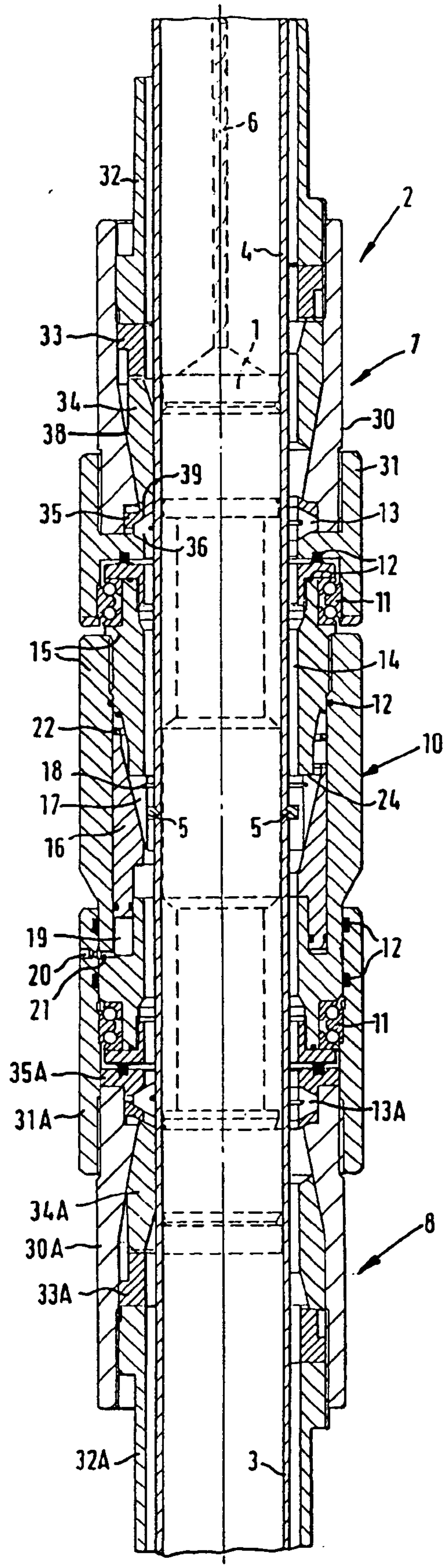
6
32
2
4
1
33
7
34
30
38
31
39
35
13
36
12
11
15
14
12
22
10
18
24
17
5
5
16
19
12
20
21
11
35A
31A
13A
34A
30A
8
33A
32A
3

FIG. 1

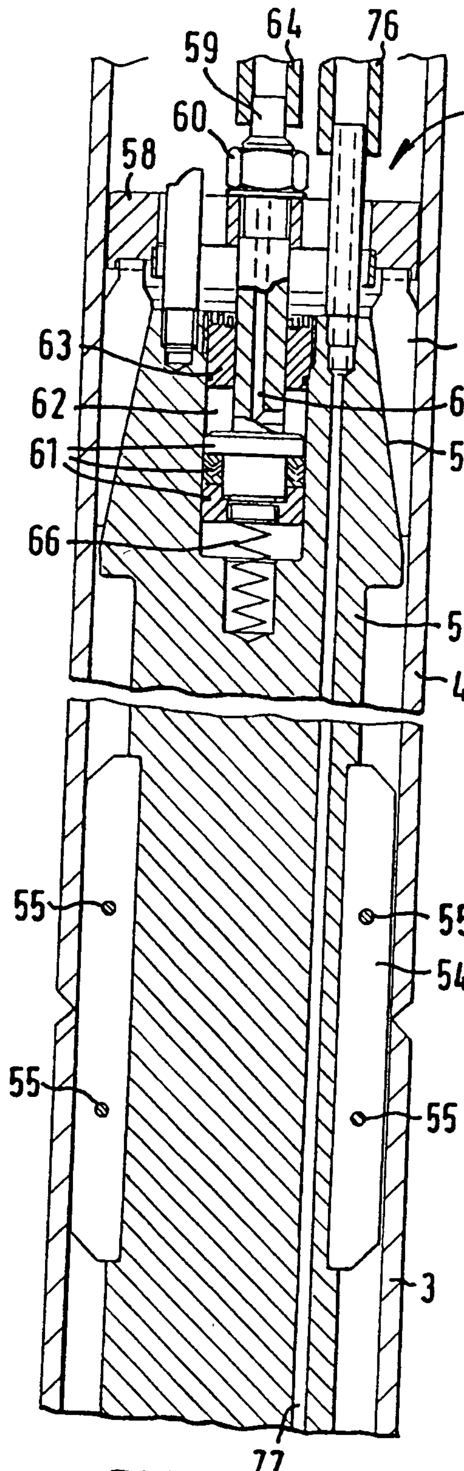
64
76
59
60
1
58
63
52
62
65
61
57
66
50
4
55
55
54
55
55
3
77

FIG.2A

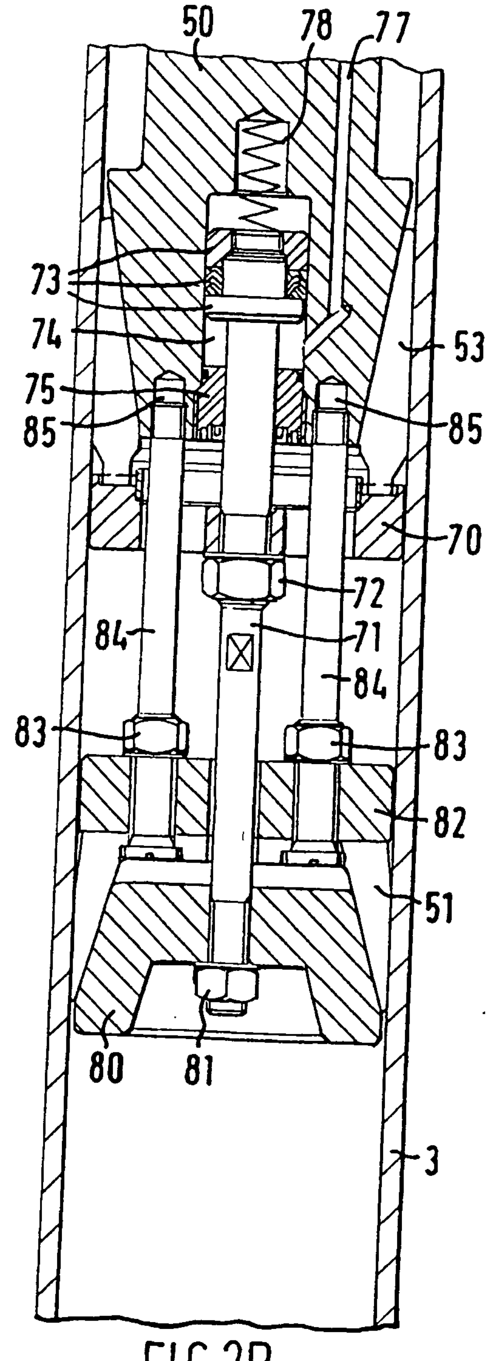
50
78
77
73
74
53
75
85
85
70
72
71
84
84
83
83
82
51
80
81
3

FIG.2B